Fermilab ILC R&D Plan for FY06

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R&D Goals

- Fermilab ILC R&D is focused on addressing the key ILC design and technical issues, cost reduction and US industrial involvement in ILC. These goals are aimed towards the development of the ILC Technical Design Report.

- The R&D goals are designed to establish the viability of all technical components addressing TRC Ranked R&D goals, costs, engineering designs to enable “early” decision (by 2010) and to position the US (and Fermilab) to host the ILC.

- The main thrust of the Fermilab ILC R&D is to establish US technical capabilities in the Superconducting Radio Frequency Cavity and Cryomodule technology. The main goals described in detail in the proposal are

  – 1) Cavity technology development in the US to routinely achieve $\geq$ 35 MV/m and Q ~0.5-1e10,

  – 2) ILC Cryomodule design, fabrication and cost reduction

  – 3) Fully tested basic building blocks of the Main Linac, Evaluate the reliabilities issues.

  – 4) Accelerator design issues in the Main Linac, Damping Ring and Machine Detector Interface

  – 5) Development of an ILC site near Fermilab.

- While focused on the long term goals for ILC design and construction, Fermilab will also work with the GDE in development of the Reference Design Report, taking responsibilities for the chapters on Main Linac and US Site, by the end of FY06.

Reference Design Report

- Fermilab plans to take the full ownership of the Baseline Configuration Document (BCD) and the Reference Design Report (RDR).
- We are proposing to take the responsibilities of writing the following two chapters
  - Main Linac
  - US ILC Site and Conventional Facility near Fermilab
- Fermilab will also participate in the accelerator physics and design of Damping Ring and Machine Detector Interface.
- We have a growing interest in Instrumentation and controls for ILC.
- Fermilab will participate in overall BCD and RDR including overall parameters, cost, schedule, availability and risk analysis.

Accelerator Physics

- ILC Main Linac Lattice and Low Emittance Transport Studies.
  - Full linac simulation including feedback, beam- beam interaction at IR.
- Alignment and Vibration
  - Systematic Data collection and analysis
  - Measurement of vibration from surface to ILC Depth near Fermilab site.
- Damping Ring (Dog Bone and Fermilab-Cornell-Argonne Damping Ring (FCAD))
  - Lattice Design, Instabilities, Cost etc.
- Machine Detector Interface and Energy Deposition Studies
  - Energy Deposition and collimation for BDS and IR
  - Background in detector and its mitigation
  - Treatment of the spent beam downstream of IR.

US-ILC Site Development

- Fermilab in collaboration with SLAC is leading the development of a site analysis
  - The sites will be compare on 9 criteria
- At present we are looking at 5 potential site near Fermilab.
- There are several issues form accelerator design that needs to feed into these studies
  - 1 tunnel vs 2 tunnels
  - Deep or shallow layout
  - Laser straight linac, follow the earth curvature, laser straight in segments

ILC Site Evaluation Criteria

1. Site Impact on critical science parameter
2. Scientific and Institutional Support Base
3. Land Acquisition
4. Environmental Impacts
5. Construction Cost Impacts
6. Operational Cost Impacts
7. ES&H
8. Regional Infrastructure Support
9. Risk Factors

ILC Accelerator Technology R&D

- Accelerator Technology goals are focused to address the ILC-TRC R1 and R2.

- Energy R1: The feasibility demonstration for the ILC requires that a cryomodule be assembled and tested at the design gradient of 35 MV/m. This test should prove that the quench rates and breakdowns, including couplers, are commensurate with the operating expectations. It should be shown that dark currents at the design gradient are manageable, which means several cavities should be assembled together in a cryomodule.

  - Cavity technology development in the US to routinely achieve $\geq$ 35 MV/m and Q ~0.5-1e10,

- Energy R2: To finalize the design choices and evaluate the reliability issues it is important to fully test the basic building block of the linac. This means several cryomodules installed in their future machine environment, with all auxiliaries running, like pumps, controls etc. This test should as much as possible simulate the realistic machine operating conditions, with the proposed klystron, power distribution system and with beam. The cavities must be equipped with their final HOM couplers. The cavity relative alignment must be shown to be within requirements. The cryomodules must be run at or above their nominal field for long enough periods to realistically evaluate their quench and breakdown rates.

  - ILC Cryomodule design, fabrication and cost reduction
  - Fully tested basic building blocks of the Main Linac with beam, Evaluate the reliabilities issues.

ILC R&D at Fermilab FY06 Goals

- Baseline Configuration Document and Reference Design Report
- Accelerator design
  - Main Linac
  - Damping Ring
  - Machine Detector Interface
- Fermilab site development
- Cavity Fabrication and Processing Technology
  - Development of the BCP parameter at Cornell (25 MV/m)
  - Development of the EP parameters at Jlab (35 MV/m)
  - 25 MV/m cavities fabricated and Tested (VDT/HDT) with BCP using US industrial production and FNAL/ANL processing.
  - Study and Develop infrastructure for EP at FNAL/ANL
- First US assembled cryomodule Type III+ to study design and cost reduction issues
- International collaboration on the Design of an ILC Cryomodule
- Develop industrial base in US for Main Linac Components.

ILC Cavities Plan FY05-06

- Four cavities from DESY to get the tooling and processing infrastructure started at Cornell and Jlab ASAP.

- One cavity from DESY (Capture Cavity) to get the Meson infrastructure up and running.

- 4 cavities each from (AES and ACCEL). These cavities will be processed at Cornell and Jlab. The goal is to develop BCP and EP processing parameters, train people and get industry involved.

- US-Japan agreement to provide 4 processed and VDT tested cavities.

- 8 Dressed cavities from DESY. These cavities will be electro polished, vertical test, Dressed and horizontally tested and sealed. (This is in exchange of 3.9 GHz cavities and cryomodule Fermilab is fabricating for DESY.)

- FY06: US Industry to fabricate cavities for US production and tight loop processing.

- Develop Reentrant cavity and Single crystal (Standard Design) cavities.

ILC Cavity Plan FY05-06

- The plan is to get a few cavities (2-4) from DESY to get the tooling and processing started at Cornell and Jlab ASAP.

- One additional cavity is coming to Fermilab (Called Capture Cavity). This cavity will be used to get our Meson Infrastructure up and running.

- All of these cavities are expected to be about 25 MV/m. Getting processing started and infrastructure in place ASAP and US (Fermilab) people trained in this is important.

- We have ordered 4 cavities from AES. These cavities will be fabricated by AES. It will be get BCP and Vertical test at Cornell. At Cornell the AES and Fermilab staff will participate in the work for transfer of technology. Our hope is that AES will develop the BCP process at its facility. The goal is to develop 25 MV/m BCP parameters.

ILC Cavity Plan FY05-06

- These cavities will than go to Jlab for electro polishing, vertical testing and dressing. We have also proposed to Jlab that FNAL staff (SMTF collaborators) will participate in these activities. The goal is to develop 35 MV/m EP parameters.

- Horizontal testing and string assembly will take place at Fermilab. Fermilab is developing infrastructure to support this.

- Similarly we have also ordered 4 cavities from ACCEL. These cavities will follow the same path as AES cavities.

- Using the US-Japan agreement we are expecting to receive 4 Low Loss design cavities from KEK. We are in negotiation with KEK on at what stage these cavities will be shipped. Our preference is that it is shipped dressed from KEK after EP but we will be happy if we get it after EP. We are in discussions with KEK on a MOU for these cavities and their design.

ILC Cavity Plan FY05-06

- We are working on a MOU with DESY to receive 8 dressed cavities by June 2006. Discussion on these cavities have been going on for more than one year. Initially DESY was supposed to send us a full cryomodule kit but it appears that we would get only the cavities.

- We are in process of ordering cold mass for this cryomodule in FY05. We are also building assembly infrastructure at Fermilab. At present we plan to use these cavities in assembling the 1st US assembled cryomodule.

- We are installing the BCP facility at ANL after it was made to work at Fermilab. It is expected to be operational by early CY06. We are developing tooling to handle 1.3 GHz cavities in this BCP facility.

- We have a HPR system at Fermilab that would require small upgrade to handle the volume.

- We have started a discussion with LANL, ANL and KEK in helping us with the design of EP system at Fermilab. We are planning to develop a common design using the expert help from DESY, Jlab and KEK. The goal is to have a EP system by 2007.

ILC Cavity Plan FY05-06

- Tsuyoshi Tajima, LANL has worked on the KEK EP system for 2 years and has SRF expertise. He is available to work with us in learning the Jlab, DESY and KEK system and help design and build a new system at Fermilab.

- We have a PO to purchase Nb for 24 cavities waiting for funding. It is cost effective to buy Nb in bulk and also we plan to get to process 2 cavities/month by the end of FY06.

- These cavities will be produced by the US industries and processed at Fermilab. These cavities will be used for Phase 2 production and processing 35 MV/m cavity technology development.

- We also interested is supporting (FY06) at a few 9 Cell cavities level each the Single Crystal (Standard Design) R&D at Jlab and Reentrant cavity R&D at Cornell.

1.3 GHz Cavity Development

- The strategic approach we are taking is to involve “US” industry in the Cavity Fabrication.

- Cavity ordered placed (These cavities will be processed and VDT (Cornell and Jlab))
  - 4 AES
  - 4 ACCEL

- Cavities expected from other labs (These cavities are EP)
  - 8 + (4 DESY may not be EP and cryomodule quality)
  - 4 KEK (Type of the cavity still under discussion)

ILC Cavity Processing

- 4 DESY cavities will be used to develop tooling, initial processing etc. at Cornell, Jlab and ANL for the processing of 1.3 GHz cavities.
- In the Phase I the plan is
  - Upgrade infrastructures at Cornell (BCP) and Jlab (EP) to process and vertical test 1.3 GHz cavities.
  - Use the Cornell BCP and VDT facility to develop BCP parameters (25 MV/m).
  - Use the Jlab EP and VDT facility to develop EP parameters (35 MV/m).
  - Develop HPR, BCP and EP facility at FNAL/ANL

Cavity Processing

- In Phase 2 (Tight Loop Production and Processing)
  - Use Cavity produces by industry
  - Process cavity at FNAL/ANL BCP
  - Study development of an EP facility at FNAL/ANL
    - Discussion has taken place between Fermilab, LANL, ANL and KEK to develop a EP facility for ILC.

At the end of this phase we will have two facilities each in US for BCP and EP Processing capable of producing 35 MV/m cavities.

1) BCP facilities at Cornell and ANL/FNAL
2) EP facilities at Jlab and ANL/FNAL

Infrastructure for ILC Cavity

- Infrastructure at Cornell and Jlab needs upgrade to process the 1.3 GHz cavities.
- Fermilab is working on installation and commissioning of the BCP facility at ANL (FY06)
- Fermilab will need a clean room for these cavities and its dressing for the Horizontal test. This is part of the Cryomodule Assembly Facility.
- Fermilab is building a horizontal test stand and plans to build a vertical test stand. Need cryogenic, RF Power, controls etc.
- We need to develop the EP facility at ANL/FNAL.

Cryomodule Design and Fabrication

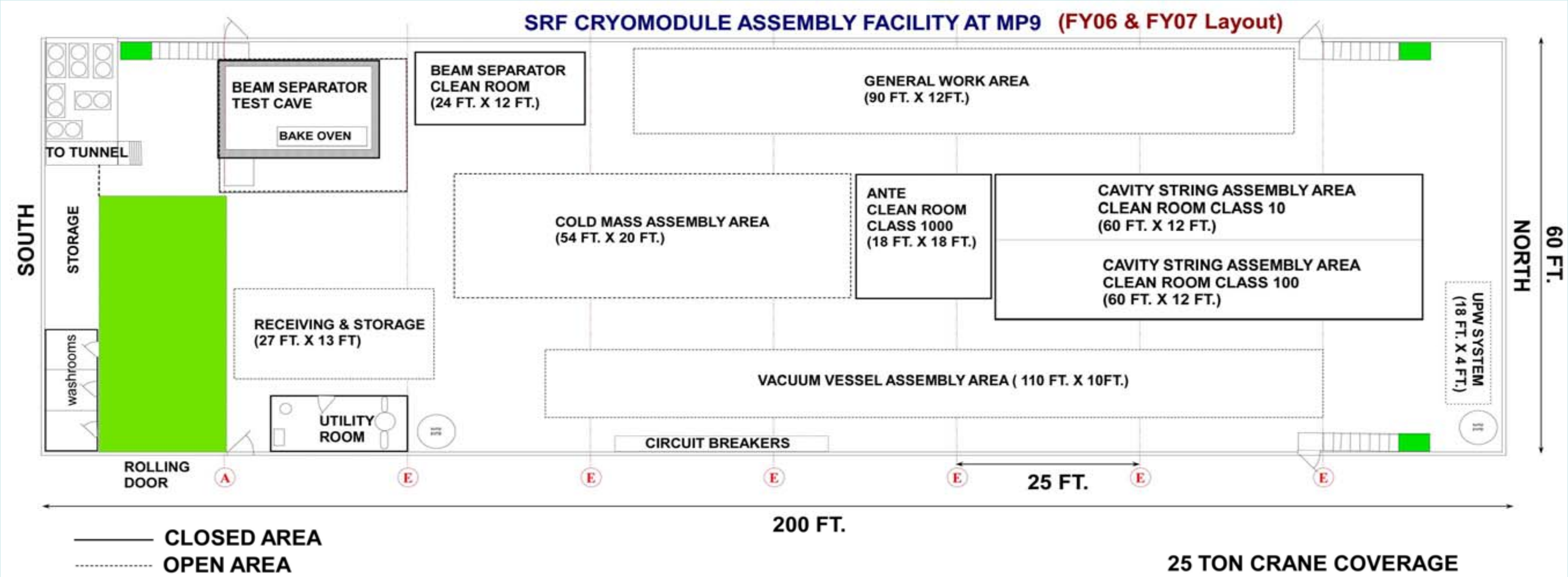
- In FY05 we started on converting the DESY & INFN design of the ILC cryomodule in the US system.
- This work is almost complete and we are in position to order parts for a cryomodule fabrication using the 20 cavities we expect to have by mid FY06.
- The cryomodule is the significant cost in the Main Linac as compared to cavities.
- Fermilab with its considerable experience in assembling large object can help improve the design and fabrication of ILC cryomodule design.
- It is important that we put together a cryomodule.

Cryomodule Design

- Fermilab has started a global discussion on the ILC Cryomodule design. (DESY, INFN, KEK and Fermilab)
- The current design does not have all the knowledge from the cryomodule fabrication at DESY.
- Also there exists a general view is that current design needs to evolve.
- Fermilab has been in discussion with two companies who plans to participate in cryomodule fabrication with a view of fabricating it at there factory at a later date.
- Fermilab plans to work towards the ILC cryomodule design after it has experience in building one.

Cavity Testing And Cryomodule Fabrication

- Cavity is produced, processed and vertically tested at SMTF collaborating institutions and start-up US industries.
- Cavity is horizontally tested at Fermilab and assembled into a string at MP9.
- Cryomodule fabrication takes place at MP9.
- Single cryomodule will be tested at the Meson Test Area.



FY06 Goals (Full Proposal)

- Reference Design Report and Accelerator Physics
- Upgrade infrastructures at Cornell (BCP) and Jlab (EP) to process cavities produced in 1st phase.
- Develop BCP and EP processing parameters to achieve 35 MV/m using Cornell and Jlab facilities.
- Develop infrastructure to assemble cavity strings and cryomodules at Fermilab
- First US assembled cryomodule Type III+ using BCP and EP cavities from Cornell and Jlab processing.
- Fermilab site development
- Commission the FNAL/ANL BCP facility to process cavities produced in 2nd Phase.
- Commission the Single Cavity Horizontal Test Stand at Fermilab.
- 25 MV/m cavities fabricated and Tested (Vertical/Horizontal) in USA with BCP at FNAL/ANL.
- Develop infrastructure for EP at FNAL/ANL
- Design and construction of a Single Cavity Vertical Test Stand at Fermilab
- Design and initial fabrication parts for an ILC Cryomodule (4th generation)
- Develop High Power Test Facility Infrastructure to cool down, power and test with beam 1st US assembled Cryomodule

FY06 Goals (Medium)

- Reference Design Report and Accelerator Physics
- Upgrade infrastructures at Cornell (BCP) and Jlab (EP) to process cavities produced in 1st phase.
- Develop BCP and EP processing parameters to achieve 35 MV/m using Cornell and Jlab facilities.
- Develop infrastructure to assemble cavity strings and cryomodules at Fermilab
- First US assembled cryomodule Type III+ using BCP and EP cavities from Cornell and Jlab processing.
- Fermilab site development
- Commission the FNAL/ANL BCP facility to process cavities produced in 2nd Phase.
- Commission the Single Cavity Horizontal Test Stand at Fermilab.
- 25 MV/m cavities fabricated and Tested (Vertical/Horizontal) in USA with BCP at FNAL/ANL.
- Complete Design of and begin construction of EP Facility at FNAL/ANL.
- Design and start construction of a Single Cavity Vertical Test Stand at Fermilab
- Design of an ILC Cryomodule

FY06 Goals (Low)

- Reference Design Report and Accelerator Physics
- Upgrade infrastructures at Cornell (BCP) and Jlab (EP) to process cavities produced in 1st phase.
- Develop BCP and EP processing parameters to achieve 35 MV/m using Cornell and Jlab facilities.
- Develop infrastructure to assemble cavity strings and cryomodules at Fermilab
- First US assembled cryomodule Type III+ using BCP and EP cavities from Cornell and Jlab processing.
- Fermilab site development
- Commission the FNAL/ANL BCP facility to process cavities produced in 2nd Phase.
- Commission the Single Cavity Horizontal Test Stand at Fermilab.
- Limited studies of cavities fabricated and Tested (Horizontal at FNAL) in USA with BCP at FNAL/ANL to achieve 25 MV/m.
- Design study for an EP Facility at FNAL/ANL.
- Limited design of an ILC Cryomodule